SCIENCE.—SUPPLEMENT.

FRIDAY, JUNE 25, 1886.

THE PHYSICAL LABORATORY IN MODERN EDUCATION.[1]

FROM the moment we are born into this world, down to the day when we leave it, we are called upon every moment to exercise our judgment with respect to matters pertaining to our welfare. While nature has supplied us with instincts which take the place of reason in our infancy, and which form the basis of action in very many persons through life, yet more and more as the world progresses, and as we depart from the age of childhood, we are forced to discriminate between right and wrong, between truth and falsehood. No longer can we shelter ourselves behind those in authority over us, but we must come to the front, and each one decide for himself what to believe and how to act in the daily routine and the emergencies of life. This is not given to us as a duty which we can neglect, if we please, but it is that which every man or woman, consciously or unconsciously, must go through with.

Most persons cut this gordian knot, which they cannot untangle, by accepting the opinions which have been taught them, and which appear correct to their particular circle of friends and associates: others take the opposite extreme, and, with intellectual arrogance, seek to build up their opinions and beliefs from the very foundation, individually and alone, without help from others. Intermediate between these two extremes comes the man with full respect for the opinions of those around him, and yet with such discrimination that he sees a chance of error in all, and most of all in himself. He has a longing for the truth, and is willing to test himself, to test others, and to test nature, until he finds it. He has the courage of his opinions when thus carefully formed, and is then, but not till then, willing to stand before the world and proclaim what he considers the truth. Like Galileo and Copernicus, he inaugurates a new era in science, or, like Luther, in the religious belief of mankind. He neither shrinks within himself at the thought of having an opinion of his own, nor yet believes it to be the only one worth considering in the world; he is neither crushed with intellectual humility, nor yet exalted with intellectual pride; he sees that the problems of nature and society can be solved, and yet he knows that this can only come about by the combined intellect of the world acting through ages of time, and that he, though his intellect were that of Newton, can, at best, do very little toward it. Knowing this, he seeks all the aids in his power to ascertain the truth; and if he, through either ambition or love of truth, wishes to impress his opinions on the world, he first takes care to have them correct. Above all, he is willing to abstain from having opinions on subjects of which he knows nothing.

It is the province of modern education to form such a mind, while at the same time giving to it enough knowledge to have a broad outlook over the world of science, art, and letters. Time will not permit me to discuss the subject of education in general, and, indeed, I would be transgressing the principles above laid down if I should attempt it. I shall only call attention, at this present time, to the place of the laboratory in modern education. I have often had a great desire to know the state of mind of the more eminent of mankind before modern science changed the world to its present condition, and exercised its influence on all departments of knowledge and speculation. But I have failed to picture to myself clearly such a mind; while, at the same time, the study of human nature, as it exists at present, shows me much that I suppose to be in common with it. As far as I can see, the unscientific mind differs from the scientific in this, that it is willing to accept and make statements of which it has no clear conception to begin with, and of whose truth it is not assured. It is an irresponsible state of mind without clearness of conception, where the connection between the thought and its object is of the vaguest description. It is the state of mind where opinions are given and accepted without ever being subjected to rigid tests, and it may have some connection with that state of mind where every thing has a personal aspect, and we are guided by feelings rather than reason.

When, by education, we attempt to correct these faults, it is necessary that we have some standard of absolute truth; that we bring the mind in direct contact with it, and let it be convinced of its errors again and again. We may state, like the philosophers who lived before

[1] Address delivered at the tenth anniversary of the Johns Hopkins university.

Galileo, that large bodies fall faster than small ones; but, when we see them strike the ground together, we know that our previous opinion was false, and we learn that even the intellect of an Aristotle may be mistaken. Thus we are taught care in the formation of our opinions, and find that the unguided human mind goes astray almost without fail. We must correct it constantly, and convince it of error over and over again, until it discovers the proper method of reasoning, which will surely accord with the truth in whatever conclusions it may reach. There is, however, danger in this process that the mind may become overcautious, and thus present a weakness when brought in contact with an unscrupulous person, who cares little for truth and a great deal for effect. But if we believe in the maxim that truth will prevail, and consider it the duty of all educated men to aid its progress, the kind of mind which I describe is the proper one to foster by education. Let the student be brought face to face with nature; let him exercise his reason with respect to the simplest physical phenomenon, and then, in the laboratory, put his opinions to the test: the result is invariably humility, for he finds that nature has laws which must be discovered by labor and toil, and not by wild flights of the imagination, and scintillations of so-called genius.

Those who have studied the present state of education in the schools and colleges tell us that most subjects, including the sciences, are taught as an exercise to the memory. I myself have witnessed the melancholy sight, in a fashionable school for young ladies, of those who were born to be intel lectual beings reciting page after page from memory, without any effort being made to discover whether they understood the subject or not. There are even many schools, so called, where the subject of physics or natural philosophy itself is taught, without even a class experiment to illustrate the subject and connect the words with ideas. Words — mere words — are taught, and a state of mind far different from that above described is produced. If one were required to find a system of education which would the most surely and certainly disgust the student with any subject, I can conceive of none which would do this more quickly than this method, where he is forced to learn what he does not understand. It is said of the great Faraday that he never could understand any scientific experiment thoroughly until he had not only seen it performed by others, but had performed it himself. Shall we, then, expect children and youth to do what Faraday could not do? A thousand times better never teach the subject at all.

Tastes differ, but we may safely say that every subject of study which is thoroughly understood is a pleasure to the student. The healthy mind as well as the healthy body craves exercise, and the school-room or the lecture-room should be a source of positive enjoyment to those who enter it. Above all, the study of nature, from the magnificent universe, across which light itself, at the rate of 186,000 miles per second, cannot go in less than hundreds of years, down to the atom of which millions are required to build up the smallest microscopic object, should be the most interesting subject brought to the notice of the student.

Some are born blind to the beauties of the world around them, some have their tastes better developed in other directions, and some have minds incapable of ever understanding the simplest natural phenomenon; but there is also a large class of students who have at least ordinary powers and ordinary tastes for scientific pursuits. To train the powers of observation and classification, let them study natural history, not only from books, but from prepared specimens or directly from nature; to give care in experiment, and convince them that nature forgives no error, let them enter the chemical laboratory; to train them in exact and logical powers of reasoning, let them study mathematics: but to combine all this training in one, and exhibit to their minds the most perfect and systematic method of discovering the exact laws of nature, let them study physics and astronomy, where observation, common sense, and mathematics go hand in hand. The object of education is not only to produce a man who *knows*, but one who *does;* who makes his mark in the struggle of life, and succeeds well in whatever he undertakes; who can solve the problems of nature and of humanity as they arise; and who, when, he knows he is right, can boldly convince the world of the fact. Men of action are needed as well as men of thought.

There is no doubt in my mind that this is the point in which much of our modern education fails. Why is it? I answer, that the memory alone is trained, and the reason and judgment are used merely to refer matters to some authority who is considered final, and, worse than all, they are not trained to apply their knowledge constantly. To produce men of action, they must be trained in action. If the languages be studied, they must be made to translate from one language to the other until they have perfect facility in the process. If mathematics be studied, they must work problems, more problems, and problems again, until they have the use of what they know. If they study the sciences, they must enter the laboratory, and stand face to face with nature; they must learn to test their knowledge constant-

ly, and thus see for themselves the sad results of vague speculation; they must learn by direct experiment that there is such a thing in the world as truth, and that their own mind is most liable to error; they must try experiment after experiment, and work problem after problem, until they become men of action, and not of theory.

This, then, is the use of the laboratory in general education, — to train the mind in right modes of thought by constantly bringing it in contact with absolute truth, and to give it a pleasant and profitable exercise, which will call all its powers of reason and imagination into play. Its use in the special training of scientists needs no remark, for it is well known that it is absolutely essential. The only question is, whether the education of specialists in science is worth undertaking at all; and of these I have only to consider natural philosophers or physicists. I might point to the world around me, to the steam-engine, to labor-saving machinery, to the telegraph, to all those inventions which make the present age the 'age of electricity,' and let that be my answer. Nobody could gainsay that the answer would be complete; for all are benefited by these applications of science, and he would be considered absurd who did not recognize their value. These follow in the train of physics, but they are not physics: the cultivation of physics brings them, and always will bring them; for the selfishness of mankind can always be relied upon to turn all things to profit. But in the education pertaining to a university we look for other results. The special physicist trained there must be taught to cultivate his science for its own sake. He must go forth into the world with enthusiasm for it, and try to draw others into an appreciation of it, doing his part to convince the world that the study of nature is one of the most noble of pursuits, that there are other things worthy of the attention of mankind besides the pursuit of wealth. He must push forward, and do what he can, according to his ability, to further the progress of his science.

Thus does the university, from its physical laboratory, send forth into the world the trained physicist to advance his science, and to carry to other colleges and technical schools his enthusiasm and knowledge. Thus the whole country is educated in the subject, and others are taught to devote their lives to its pursuit, while some make the applications to the ordinary pursuits of life that are appreciated by all.

But for myself I value in a scientific mind most of all that love of truth, that care in its pursuit, and that humility of mind, which makes the possibility of error always present more than any other quality. This is the mind which has built up modern science to its present perfection, which has laid one stone upon the other with such care that it to-day offers to the world the most complete monument to human reason. This is the mind which is destined to govern the world in the future, and to solve problems pertaining to politics and humanity as well as to inanimate nature.

It is the only mind which appreciates the imperfections of the human reason, and is thus careful to guard against them. It is the only mind that values the truth as it should be valued, and ignores all personal feeling in its pursuit. And this is the mind the physical laboratory is built to cultivate.

HENRY A. ROWLAND.

THE FORMATION OF STRUCTURELESS CHALK BY SEAWEEDS.

CHALK has hitherto been believed to be a deep-sea formation only, made up of a fine ooze or mud at great depths, and undoubtedly, so far as the extensive cretaceous deposits are concerned, the explanation is the correct one; but recent observations by Mr. J. Walther on the chalk-secreting algae of the Mediterranean show that its formation often occurs in shallow water. It has been known for some time that the nullipores were chalk-secreting algae, and that under certain conditions, as in the formation of coral islands, they took more or less part in the production of rock. Where their remains are found in any abundance, chalk formations are readily enough ascribed to their agency, but it is now shown that more or less extensive beds, or rather banks, of wholly structureless chalk, whose origin has been oftentimes enigmatical, may be entirely due to seaweeds.

Mr. Walther observed certain forms (Lithothamnia) in different places in the Gulf of Naples, growing luxuriantly at a depth of from one to three hundred feet below the surface, and traced out the relation between the masses of dead residual matter and the incompletely transformed beds of fossil chalk. These Lithothamniae have a remarkably small proportion of organic material (not more than five or six per cent), nearly the entire substance consisting of mineral matter, chiefly carbonate of lime. The plants reach only the size of one's fist, and do not change their form at death, owing to the small quantity of decaying matter they contain. The living plants secure attachment to the dead ones, forming extensive beds. The numerous stout branches of less than a fourth of an inch in length admit of only small interstices; in slow-growing beds inequalities and shallow depressions may be filled with layers of detritus.

The organic structure disappears to a greater or

less extent, often wholly, so that the chalk becomes entirely structureless; and it has been shown that the absence of structure becomes more apparent in proportion to the greater thickness of beds formed. The further transformation was traced by Walther in a recent tertiary formation at Syracuse, where he found, in the exposed quarries of Latomia dei Capuccini, the remains of Lithothamnia sufficiently distinct for determination, especially where the interstitial material had been weathered out. The stone, however, blended from this indistinctly structural form to the wholly structureless or homogeneous.

The explanation of this complete transformation, as given by the author, is also of interest. The organic substances, which in the living plant amount to about five or six per cent, were found, in the tertiary chalk above referred to, to be about a third of one per cent. The larger part had thus disappeared; and as the chalk was purely white, showing the absence of all bituminous matter, it was evident that the remaining organic matter had slowly been oxidized, producing carbonic matter, which had obliterated by its dissolving action in the surrounding or percolating water all evidences of structure. In such cases where the plants were exposed to water not impregnated with the carbonic acid, the structure is retained more or less unimpaired.

This explanation of the formation of chalk in shallow waters — for algae must live within a few hundred feet of the surface, where light can reach them — gives a solution of various problems in geology, especially of the more recent chalk-beds. Whether it will apply to the extensive structureless chalk-beds of western Kansas at all, is doubtful.

CYPRUS UNDER BRITISH RULE.

At a recent meeting of the Society of arts, in London, Mr. G. Gordon Hake read a paper on the condition of Cyprus since its occupation by the British, his object being to show the improvements that have taken place under the new administration.

In ancient times Cyprus was one of the most fertile and prosperous countries in the world, its copper and its timber being important articles of commerce. But under the Turkish administration the island deteriorated greatly, as most countries do under Turkish rule. One traveller, near the end of the last century, describes Famagusta, at the time of his visit, as a "melancholy picture of Turkish desolation," and as "almost depopulated, although, in the time of the Venetians, the finest city in the island, and renowned for its brave defence against the infidels." He adds, "The desolation we observed at Famagusta extended itself along the country. We passed by the ruins of several Greek villages." Another traveller also gives a sad account of Cyprus at a rather later date. "The island," he says, "was formerly one of the richest and most fertile in the world. It is much exposed to the ravages of locusts. On their approach, every kind of verdure disappears, and they even gnaw the very bark off the trees. The Turks will not permit their destruction, because they consider them as sent by the Almighty."

This melancholy condition of the island was due in part to maladministration of justice, and in part to a vicious system of taxation. The Turkish government took tithes of the produce of the land, and these tithes were farmed in the spring of each year to merchants and speculators. This system had its natural results in a loss of revenue to the state, and the impoverishment of the cultivator, whom it involved in the toils of the money-lender, as well as the tithe-farmer, and thus checked the productiveness of the island to an enormous extent. The land, falling out of cultivation, became the breeding-ground of locusts. The cultivators of the soil in many cases gave up their calling in despair, and obtained a living by cutting down and selling trees, and the collection of resin. The wholesale destruction of trees reacted on the climate, and restricted the rainfall; so that between locusts, tithe-farmers, and neglect of the forests, the island, at the time of the occupation, was rapidly becoming more like a barren, rocky desert than a fertile and naturally favored country.

These, then, were the chief evils to be remedied by the English on their arrival in Cyprus. It was at once made plainly known that no farming of tithes would be allowed under British rule; and it was decided to adopt the following course in regard to the same. The Turkish plan of assessment was to be followed, but, instead of collecting the tithes in kind, they were to be valued, and, leaving the peasant free to deal with his crop as he pleased, the money value was to be collected as an ordinary tax later in the year. The sole exceptions to this were the tithes on silk and carobs. The greater portion of these two products being exported from the island, it was arranged to collect the tithe on export, and so save the cost of assessment; and the result, besides being successful from the imperial point of view, has given great satisfaction to the agriculturists.

After this financial reform the locust and timber questions remained to be dealt with. The Cyprus locust is indigenous to the island; and its presence is, without doubt, largely due to past

mismanagement and neglect of the soil, inasmuch as it is only on rocky waste ground that the female insect will lay her eggs. The locust-plague is therefore the result of inadequate cultivation of the soil, consequent upon a deficiency of population, coupled with an insufficiency of trees; though their increase may be largely attributed to the Mussulman theory of resignation, which would not, in former times, permit their destruction on account of the belief that they were sent by the Almighty. For some years prior to 1862 the destruction of crops from this cause was very large, and the plan of egg-collection was then tried, without success, by the Turkish government. This led Mr. Richard Mattei, a land-owner of Cyprus, to commence a series of experiments, which resulted in the invention of his system of traps and screens. Mr. Mattei had the good fortune to secure the assistance of the Turkish governor, Said Pacha, a man of exceptional intelligence and energy; and in 1870, after long effort, the locusts were by this means almost exterminated. Not wholly, however; for in 1875 they reappeared, and, another governor being in power, they were allowed to increase until the time of the British occupation. Early in 1879, measures were adopted by the English government, both by the employment of Mr. Mattei's trap and screen system and by encouraging the collection of locust-eggs, for which they offered a considerable price. These measures have been completely successful, as the locusts that appeared last year were comparatively few in number, and did no appreciable damage, and any future visit may be looked forward to with complacency.

But the forests of the island also demanded and received the attention of the new authorities. The forests were placed under control, and the destruction of wood prohibited, moderate supplies being permitted for native wants. The indiscriminate pasturage of goats has been stopped, and a large number of trees have been planted, the chief species being Aleppo pine, cypress, carob, ailantus, oak, mimosa, eucalyptus, and Pinus pinea. The effect of these measures has been favorable; but the restoration of the forests must necessarily be a work of time.

Again, it was necessary to reform the administration of justice throughout the island. This was effected by a complete re-organization of the department of justice under the direction of the home government. The most salient features of the scheme were the formation of a court of appeal, composed of two qualified English judges, the appointment of an English judge to preside in every district, and the establishment of a number of village judges to deal with petty civil cases. It included also the adequate payment of the native judges, although their number was gradually reduced to a considerable extent, and likewise established a system of jail deliveries by judges on circuit, similar to that which prevails in England.

The effect of these and other less important reforms on the commerce of the island has been highly beneficial. The abolition of the tithe-farming system, and the adoption of the more generous as well as more politic measure, whereby the agriculturist was permitted to deal with his crop as he pleased, the collection of the tax being delayed till a later season, when he should have had ample time for the conversion into money of the produce of his holding, had a most favorable influence on the particular industries affected, and consequently on the trade of the island generally. The volume of foreign trade, which in Turkish times was estimated at £1 10s. per head of the population, amounted, in 1879, to £2; in 1880, to £2 10s.; and in 1881, to £3 per head, since which time steady increases have been recorded. The net result of British occupation to Cypriot commerce may be fairly estimated by a comparison of the respective imports and exports for 1878, the last year of Ottoman rule, with those of 1884–85. The imports for 1878 were £177,651; for 1884–85, £304,375. The exports in 1878 were £157,328; last year they amounted to £287,521; and the figures were still higher the year before, especially as regards the imports.

Mr. Hake concluded his paper with a few remarks on the further improvements which he deems necessary for the prosperity of the island. Leaving out of account all minor measures, such as developing certain crops, he thinks there are three things which remain for the English to do. The first is to become the purchasers of the fee simple of the island, instead of being tenants at will, as they are at present; the second is to spend money, even to the extent of getting into debt, in order to plant the moutain-ranges, and especially the northern one that runs down the Mesaorian plain; and the third is (again getting into debt, if necessary) the establishment of a railway from Morphou to Famagusta, leaving its after-development to time, and to put the harbor of Famagusta into proper repair for mercantile use.

JEVONS'S LETTERS AND JOURNAL.

MRS. JEVONS has done well to collect these letters and journals of her late husband. The world is always interested in the personal history

Letters and journal of W. Stanley Jevons. Ed. by his wife. London, *Macmillan*, 1886. 8°.

of its benefactors; and, in the case of those whose lives are uneventful, this can only be known from their own private papers and those of their friends. Jevons was not, indeed, a man of the highest genius, and his works are not likely to make an epoch in any department of knowledge; but they are fresh in thought and often original, and nearly always provocative of thought in his readers. Moreover, he wrote a clear and easy style, which makes his letters interesting from a literary point of view.

Most of the letters in the collection before us were written to his relatives and personal friends, though many of the later ones are addressed to correspondents in the learned world. The most interesting part of the book to us is that which treats of the author's education and his early labors in the mental and social sciences. William Stanley Jevons was born in Liverpool in 1835, and met his death by drowning, at Bulverhythe, near Hastings, in 1882; so that his life covered a period of not quite forty-seven years. His father was a merchant, but failed while Stanley was a boy, after which the family were in only moderate circumstances. Stanley's mother died while he was very young, and he was taught at home by a governess until he was more than ten years old, when he was sent to school in Liverpool. At the age of fifteen he went to London to attend University college school, and afterwards studied at the college itself till he reached the age of nineteen. At that time he was offered the position of assayer in the mint at Sydney, in Australia; and, though at first averse to taking it, he ultimately accepted and retained the post for four years. The duties of the office seem never to have been much to his taste, and he had not held it long when he began to entertain designs and aspirations which rendered a return to England necessary. What these designs were he makes known in a letter to his sisters. He writes that in his inmost soul he has but "one wish, or one *intention*, viz., to be a *powerful good* in the world. To be *good*, to live with good intentions towards others, is open to all. . . . To be *powerfully good*, that is, to be good, not towards one, or a dozen, or a hundred, but towards a nation or the world, is what now absorbs me. But this assumes the possession of the *power*. . . . I also think, that, if in any thing I have the chance of acquiring the power, it is that I have some *originality*, and can strike out new things" (pp. 95, 96).

It appears, also, from another of his letters, that he had also chosen the field in which he was to work; for he writes that he intends "exchanging the physical for the moral and logical sciences, in which my *forte* will really be found to lie."

With such aspirations as these, Jevons could not be content to remain in Australia; and accordingly in 1859 he left his post at Sydney, and returned to England by way of Panama and the United States. On reaching home, he returned to study at University college, where he remained till he had taken the degree of M.A., devoting himself mainly to mental and social philosophy. After finishing his studies, he was for some time in doubt as to how he was to get his living, but was soon offered a position as tutor in Owens college, Manchester, which he accepted, being then twenty-eight years of age. A few years later he was appointed professor of philosophy and political economy in the same institution, and not long afterwards he married.

He had now attained a position which enabled him to carry on his chosen work, and he had already published some essays which had given him a reputation as an economist and statistician. The most important of these was the one on the coal-question, in which he warned his countrymen that their supply of coal was not inexhaustible. These essays did not at first attract the notice he expected, and, as he had not then attained his professorship, he seems to have suffered much from depression of spirits. Yet he did not swerve in the least from his chosen path; for he writes in his journal as follows: "Whence is this feeling that even failure in a high aim is better than success in a lower one? It must be from a higher source, for all lower nature loves and worships success and cheerful life. Yet the highest success that I feel I can worship is that of adhering to one's aims, and risking all" (p. 218). The next day after this was written, he received a letter from Mr. Gladstone, warmly commending his pamphlet on the coal-question; and from this time onward his reputation continued to grow.

Of the author's works, however, we have no space to speak at length. We cannot accord him a place among the great thinkers of the world, and it seems to us that he tried to be more original than he had the power to be, though his works are very suggestive. His mathematical theory of political economy has not been accepted by any leading thinker, and has remained thus far without influence on the development of the science. He urges that economical phenomena can be treated mathematically, because they can be expressed in terms of more and less; but, in order to treat them mathematically, we must be able to say how much more or less, and this, in the case of human desires and efforts, is impossible. Again: Jevons seems to have thought, that, in his doctrine of 'the substitution of similars,' he had presented an entirely new theory of reasoning; whereas the

doctrine in question is the basis of every system of logic in existence, and necessarily so.

Jevons was perhaps a little too apt to present his thoughts to the public before he had given them time to mature, and hence some of his theories are crude and but half worked out. Indeed, he seems in some cases to have been aware of this himself; for he writes to one of his correspondents about the 'Principles of science,' in the following terms: "To the want of a psychological analysis of the basis of reasoning I plead guilty. . . . No doubt, to a considerable extent I have avoided the true difficulties of the subject; but this does not preclude me from attempting to remedy the defect at some future time, if I live long enough, and can feel that I see my way to a more settled state of opinion" (p. 322). But, unfortunately for him and for us, he did not live long enough to finish this and other tasks that he had projected; and it is sad to think how much the world may have lost by the death, at the age of forty-six, of a man of such freshness of thought, and courage of opinion, as Jevons undoubtedly showed.

THE RAILWAYS AND THE REPUBLIC.

CAN competition be so arranged as to prevent the more serious abuses of railroad power? Can it be made to apply to railroads as it does to most other lines of business? Fifty years' experience has seemed to show that it cannot. Mr. Hudson believes that it can; and he makes out a case which will appear plausible to those who are not in a position to understand the practical difficulties involved in his project.

Each year's history shows that under our existing system — or want of system — railroad managers wield an irresponsible power, dangerous alike to shippers and to the government. By arbitrary differences in charge they can ruin the business of individuals; by political corruption they can often thwart all attempts at government control. The history of the Standard oil company, which Mr. Hudson tells extremely well, furnishes an instance of both these things. The railroads made a series of contracts with the company to do its business at much lower rates than they would give to any one else; while the railroads and the company together were able to set at nought the plainest principles of common law, to defy legislative investigation, and laugh at state authority itself.

What is to be done under these circumstances? This is the question to which Mr. Hudson addresses himself. He does not fall into the extreme of advocating state ownership. He has too strong a sense of the dangers of government management to believe that political corruption could be avoided, or enlightened economy secured, by a measure like this. Admitting, then, that railways are to remain under private ownership, how are their abuses to be brought under control? Almost every writer has his own notion on the subject, and his own individual shade of opinion; but we may group them under three main heads:—

1. There is one class of writers who insist that things are well enough as they are; who say that the reduction in rates under our present system has been so great, and the development of the country so rapid, as to outweigh any incidental evils which may exist. They say that the most we can possibly think of doing is to prohibit a few of the worst abuses, and perhaps secure a very moderate amount of publicity; and that other things will take care of themselves. This is the position of writers like Stuart Patterson or Gerritt Lansing.

2. Many of the more enlightened railroad men, like Albert Fink, G. R. Blanchard, or Charles Francis Adams, jun., do not deny the existence of most serious evils; but they attribute them to unrestricted competition, which favors competing points at the expense of local points, or places solvent roads at the mercy of bankrupt ones. They favor legalizing pools, and limiting the irresponsible construction of new roads, and think that the public interest would be best served by a responsible combination of railroads, with a commission to see that the interests of the shippers were not neglected.

3. On the other hand, Mr. Hudson insists that we have, not too much competition, but too little; that the abuses incident to its partial and irregular working can be best avoided by enabling it to act everywhere instead of nowhere. This he proposes to do by allowing others besides the railway company to use the track, on payment of a just and reasonable toll. He argues strongly to prove that this plan is not merely equitable, but practicable, and that each of the other positions is wrong, both in fact and in morals.

He has no difficulty in breaking down the arguments of the first group. The men who insist that railroad management is a private business, with which there should be no interference, and that all is well enough as it is, are every day becoming fewer. The really difficult conflict is against those who admit the evils, but who say that the remedy is to be found in well-controlled combination rather than uncontrolled competition. Mr. Hudson insists that combinations perpetrate outrages which individual roads could not perpe-

The railways and the republic. By JAMES F. HUDSON. New York, *Harper*, 1886. 8°.

trate, and that the worst abuses of railroad wars have their origin in the desire to force rival roads to a combination. Against the first of these points we may cite the testimony of Mr. Sterne, — certainly no prejudiced witness, — that the actual abuses have been lessened rather than increased when the trunk-line pool was in operation. We may cite the uniform experience of Europe, that only where pooling contracts were made permanent has it been possible to bring discrimination under control; so that men as widely distinct in their views as Gladstone and Bismarck have both sanctioned the system by their active countenance. With regard to the motive for railroad wars, we may show that it is regularly the weaker party who is the aggressor, rather than the stronger party. And finally, as a counter-argument against Mr. Hudson, it may be shown that his scheme has been found impracticable. It was tried and abandoned at the outset, as he himself admits. Every subsequent change in railroad administration has rendered the difficulties of its application greater instead of less. Both by theory and by experience, it may be shown that the attempt to treat the railway as a public highway has done some harm and no good in the past, and must grow even less possible with the increasing complication of railroad business.

OPPOLZER'S TREATISE ON ORBITS.

Oppolzer's treatise on the determination of the orbits of planets and comets is so well and favorably known to students of astronomy, that, in calling attention to the French translation of the first volume (which will be found welcome by those who do not read German with ease), we might have confined ourselves to the briefest notice, if the translator had reproduced the German edition without modification. M. Pasquier has, however, introduced, together with several minor changes, the mode of counting longitude and time recommended by the Washington international meridian congress of 1884: that is, longitudes east from Greenwich are regarded as plus, and west as minus; and the astronomical day is made to begin with mean midnight. This innovation is in accord with the ideas of Dr. Oppolzer, who is known as one of the strongest and most distinguished of the advocates of the new plan. M. Pasquier says that the change has been made in response, also, to the wishes of the majority of astronomers and of governments. It is difficult to see upon what ground such a conclusion is drawn in regard to the wishes of astronomers; the opinions published during the past year are far from indicating a majority in favor of the change; and diplomatic action, even if ratified by the countries represented, can scarcely be expected to influence astronomers in such an important matter. The course adopted by M. Pasquier we are inclined to regard as somewhat premature, and it may interfere with the general acceptance and usefulness of the translation as a text-book; but he has taken care to indicate in his preface the corrections which must be made in the text and tables, if one prefers to reckon the astronomical day from mean noon (the present custom) instead of using universal time. To quote a recent comment, "a glance at these corrections will show astronomers some of the troubles that are in store for them, should they make the change which the Washington conference has recommended."

The typography of the volume is good (we are always sorry, though, to meet with the flat-topped figure three (3), an abomination when it is found on divided circles and micrometer heads, and scarcely more legible in print), and especial pains have been taken to insure accuracy in the tables and formulae. The tables, we are told, were revised three times while the work was going through the press.

Traité de la détermination des orbites des comètes et des planètes. Par Theodore d'Oppolzer. Tr. by Ernest Pasquier. Vol. i. Paris, *Gauthier-Villars*, 1886. 4°.

The fourth volume of the 'Publications of the Washburn observatory,' which we have just received, seems to bring to a close the work undertaken at Madison by Professor Holden. The greater part of the volume is taken up with the work of the Repsold meridian circle for 1884 and 1885, — the observation of the 303 stars which are to serve as reference-points for the southern zones of the *Astronomische gesellschaft*. A casual glance shows a satisfactory performance of the instrument; but we regret with Professor Holden, that, under the circumstances, it has been possible to give merely the "results of observation, instead of accompanying them with the thorough discussion they seem to deserve." We note particularly the creditable part taken in both observations and reductions by Miss Alice Lamb, who appears in the *personnel* as one of the 'assistant astronomers.' A valuable piece of astronomical bibliography will be found in the seven pages devoted to a reference-list of the original sources from which errata have been taken in systematically correcting the star-catalogues contained in the observatory library. Some thirty pages are occupied with the results of meteorological observations; and a brief discussion is given of a longitude campaign undertaken, in co-operation with a government surveying party, to determine the western boundary of Dakota.

INDEX TO VOLUME VII.

*** Names of contributors are printed in small capitals.*

LIST OF ILLUSTRATIONS.

ERRATA.

Page 131, col. 2, 4th line from top, for 'times' read 'lines.'
" 131, " 2, 32d line from top, for 'sciences' read 'science.'
" 132, " 1, 1st line, for 'points to' read 'points.'
" 188, " 2, 27th line from bottom, for 'fifteen' read '1.5.'
" 250, " 2, 21st line from bottom, for 'two thousand' read 'two.'
" 305, " 2, 32d line from top, for 'Zygodium' read 'Lygodium.'
Page 492, col. 1, 2d line from bottom, for 'abilities' read 'utilities.'
" 535, " 2, 28th line from top, for 'them' read 'these.'
" 535, " 2, 12th line from bottom, for 'Zaphrentes' read 'Zaphrentis.'
" 536, " 1, 27th line from bottom, for 'probably' read 'possibly.'
" 536, " 1, 22d line from bottom, for 'Tahleh' read 'Zableh.'
" 536, " 2, 14th line from top, for 'there' read 'these.'